

ART 34

We claim:

- 1 1. A method for depositing onto a support one or more catalytic components,
2 said method comprising:
3 providing one or more vaporizable catalytic components;
4 converting said one or more vaporizable catalytic components into a vapor; and
5 depositing said vapor onto said support in an amount sufficient to produce a
6 concentration of said one or more catalytic components adapted to
7 produce a catalytically effective coating consisting essentially of said
8 one or more catalytic components on said support.

- 1 2 The method of claim 1 wherein at least said depositing occurs in a
2 vacuum.

- 1 3. The method of claim 1 or 2 wherein said support is a carbon catalyst
2 support.

- 1 4. The method of claim 3 wherein said carbon catalyst support comprises a
2 material selected from the group consisting of graphite, a carbon filament bundle,

3 reticulated carbon, carbon cloth, and carbon mesh.

1 5. The method of any of claims 1-4 wherein said support comprises a
2 membrane comprising a composite of polytetrafluoroethylene comprising impregnated
3 ion exchange media, said composite comprising a thickness of about 1 μm .

1 6. The method of any of claims 1-5 wherein said one or more catalytic
2 components comprises one or more noble metals.

1 7. The method of any of claims 1-6 wherein said one or more catalytic
2 components comprises one or more metals selected from the group consisting of
3 platinum, gold, silver, palladium, ruthenium, rhodium, iridium.

1 8. The method of any of claims 1-7 wherein said concentration comprises less
2 than about 0.3 mg/cm^2 .

1 9. The method of any of claims 1-7 wherein said concentration comprises less
2 than about 0.2 mg/cm^2 .

1 10. The method of any of claims 1-7 wherein said concentration comprises
2 from about 0.01 to about 0.2 mg/cm².

1 11. The method of any of claims 1-10 wherein said one or more catalytic
2 components comprise platinum.

1 12. The method of any of claims 1-11 wherein said support is a coating on a
2 carbon cloth, wherein said coating is selected from the group consisting of carbon, a
3 wet proofing material, and a combination thereof.

1 13. The method of claim 12 wherein said wet proofing material is polytetra-
2 fluoroethylene.

1 14. The method of any of claims 1-13 further comprising
2 providing a solid polymer electrolyte membrane; and
3 disposing said support in ionic communication with said solid polymer
4 electrolyte membrane.

1 15. The method of any of claims 1-14 wherein
2 said solid polymer electrolyte membrane has a first side and a second side
3 opposite said first side, and
4 said method further comprises disposing said support on each of said first side
5 and said second side to produce a membrane electrode assembly.

1 16. The method of any of claims 1-15 wherein said converting is thermally
2 converting.

1 17. The method of any of claims 1-5 wherein said one or more catalytic
2 components are metallic.

1 18. An electrode produced by a process comprising:
2 providing one or more vaporizable catalytic components;
3 converting said one or more vaporizable catalytic components into a vapor; and
4 depositing said vapor onto a support in an amount sufficient to produce a

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5 concentration of said one or more catalytic components adapted to
6 produce a catalytically effective coating consisting essentially of said
7 one or more catalytic components on said support.

1 19. The electrode of claim 18 wherein said support is a carbon catalyst support
2 comprising a material selected from the group consisting of graphite, a carbon filament
3 bundle, reticulated carbon, carbon cloth, and carbon mesh.

1 20. The electrode of claim 19 wherein said carbon catalyst support
2 comprises a material selected from the group consisting of a carbon cloth and a coating
3 on a carbon cloth selected from the group consisting of carbon, a wet proofing
4 material, and a combination thereof.

1 21. The electrode of claims 18-20 wherein said support comprises a
2 membrane comprising a composite of polytetrafluoroethylene comprising impregnated
3 ion exchange media, said composite comprising a thickness of about 1 μm .

1 22. The electrode of any of claims 18-21 wherein said one or more vaporizable
2 catalytic components comprises one or more noble metals.

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1 23. The electrode of claim 22 wherein said one or more vaporizable
2 catalytic components comprises one or more metals selected from the group consisting
3 of platinum, gold, silver, palladium, ruthenium, rhodium, iridium.

1 24. The electrode of any of claims 18-23 wherein said one or more
2 vaporizable catalytic components comprises platinum.

1 25. The electrode of any of claims 18-24 wherein said support comprises a
2 coating on a carbon cloth wherein said coating is selected from the group consisting of
3 carbon, a wet proofing material, and a combination thereof.

1 26. The electrode of claim 25 wherein said wet proofing material is
2 polytetra-fluoroethylene.

1 27. The method of any of claims 18-26 wherein said converting is thermally
2 converting.

1 28. The method of any of claims 18-21, 25, and 26 wherein said one or
2 more catalytic components are metallic.

1 29. An electrode comprising a support having disposed thereon a vapor
2 deposited electrocatalytic coating consisting essentially of one or more electrocatalysts,
3 wherein said one or more electrocatalysts are present in an amount of about 0.3
4 mg/cm² or less.

1 30. The electrode of claim 29 wherein said vapor deposited electrocatalytic
2 coating is deposited in a vacuum by electron-beam physical vapor deposition.

1 31. The electrode of claims 29 and 30 wherein, at a cell potential of about 0.6
2 V, an MEA containing said electrode half cell operating as a cathode yields about 800
3 mA cm⁻² or greater.

1 32. The electrode of claims 29-31 wherein said electrode comprises an
2 electrocatalytic active area of about 300 cm² or greater.

1 33. The electrode of claims 29-32 wherein said one or more catalytic
2 components comprises platinum.

1 34. The electrode of claims 29-33 wherein said support comprises a
2 membrane comprising a composite of polytetrafluoroethylene comprising impregnated
3 ion exchange media, said composite comprising a thickness of about 1 μm .

1 35. The electrode of claims 29-34 wherein said converting is thermally
2 converting. A

1 36. An electrode comprising a support comprising a deposit disposed
2 thereon, said deposit comprising a catalytically effective load of an electrocatalyst
3 comprising an electrocatalytic active area at least in part comprising rod-shaped
4 structures.

1 37. The electrode of claim 36 wherein said rod-like structures are visible at
2 a magnification of at least about x10k.

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1 38. The electrode of claims 36 and 37 wherein said deposit further
2 comprises particles of said electrocatalyst comprising an outer surface, wherein said
3 electrocatalytic active area comprises a majority of said outer surface of said particles.

1 39. The electrode of claims 36-38 wherein said support has a surface area, and
2 said deposit covers about 300 cm^2 or more of said surface area.

1 40. The electrode of claims 36-39 wherein said catalyst comprises platinum.

1 41. The electrode of claims 36-40 wherein, at a cell potential of about 0.6
2 V, an MEA containing said electrode as a half cell operating as a cathode yields a
3 power output of about 400 mA cm^{-2} or greater.

1 42. The electrode of claims 36-40 wherein, at a cell potential of about 0.6
2 V, an MEA containing said electrode as a half cell operating as a cathode yields a
3 power output of about 800 mA cm^{-2} or greater.

1 43. The electrode of claims 36-40 wherein, at a cell potential of about 0.6

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- 2 V, an MEA containing said electrode as a half cell operating as a cathode yields a
3 power output of about 1000 mA cm^{-2} or greater.

- 1 44. The electrode of claims 36-43 wherein said support comprises a
2 membrane comprising a composite of polytetrafluoroethylene comprising impregnated
3 ion exchange media, said composite comprising a thickness of about $1 \mu\text{m}$.

- 1 45. A membrane electrode assembly comprising the support of any of claims
2 18-44.

- 1 46. The electrode of any of claims 18-44 wherein
2 said support has a surface area; and,
3 substantially all of said surface area ionically communicates with an ionomeric
4 membrane.

- 1 47. The electrode of claim 46 wherein said surface area is 300 cm^2 or
2 greater.

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A.
B.D.

ADD A₂

add
B1

add
P1